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**COMMERCIAL CONTROL OF PECAN SCAB**

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**CAUSE AND DESCRIPTION OF PECAN SCAB**

The disease of pecans commonly known as scab is caused by a parasitic fungus which has been named and described as *Fusicladium effusum* Winter and referred to in literature under this name.<sup>1</sup>

The fungus attacks the nuts, growing twigs, and leaves of susceptible varieties. Although some injury is done to all parts attacked, the greatest damage is to the nuts. The early spring infections are first observed as elongated brown or black lesions on the veins of the under side of the leaves. On the young nuts the early infections also frequently show as elongated spots on the ridges. Spots which appear later during the season on leaves, twigs, or nuts as a rule are black, circular, and slightly raised from the surrounding tissues. These spots range from one-eighth to one-quarter of an inch in diameter. Numerous infections taking place on the nuts may become confluent and form large irregular black blotches. In extreme cases, especially with the more susceptible varieties, infections on the nut may be so numerous as to blacken the entire surface, causing premature dropping. Young nuts severely attacked may shrivel and die and remain attached to the twigs. Frequent April rains and a low

<sup>1</sup> Recent investigations by the senior writer, the results of which have not yet been reported upon, seem to demonstrate that an error has been made in naming this parasite

percentage of sunshine associated with a preponderance of the inoculum favor early spring infections. Under such conditions, initial infection occurs prior to the middle of April in the latitude of southern Georgia, and by the latter part of April or the first week in May many secondary infections may take place. The young leaves are extremely susceptible while they are unfolding, but become more resistant as they become older. As soon as they have become fully grown and have taken on the dark-green color of mature leaves they are practically immune. The nuts are susceptible until fully grown, but only the tender succulent portions of the twigs are subject to attack. The number of the early spring infections can be reduced perceptibly by practicing sanitary and prophylactic measures in a pecan orchard.

Perpetuation of the disease from one season to another is accomplished by the mycelium of the causative organism continuing to live dormant during the winter in the spots formed in late summer. Under favorable weather conditions in April, the fungus within the last year's scab spots becomes active again and produces the spores which infect the new leaves.

#### **DISTRIBUTION AND ECONOMIC IMPORTANCE**

Pecan scab is widely distributed throughout the Southeastern States, having been reported from North Carolina, South Carolina, Georgia, Florida, Alabama, Louisiana, Mississippi, Arkansas, and Texas. The disease causes most damage in northern Florida, the southernmost quarter of Georgia, Alabama, Mississippi, and Louisiana. Here the disease not only attains its greatest degree of destructiveness but a greater number of varieties are attacked than elsewhere. In the northern half of Georgia, Alabama, Mississippi, Louisiana, and eastern Texas the disease has not yet become serious except on one or two very susceptible varieties and is almost absent in the drier regions of Texas. Fewer pecan orchards, lower percentages of humidity, and less frequent summer rains prevailing in the more northern and western pecan districts are undoubtedly the main factors contributing to the lesser prevalence of the disease there.

Potentially the scab disease is of more economic importance than any other disease of pecans. Even at the present time the loss is considerable. After the fungus has once become firmly established in an orchard composed of the more susceptible varieties, the total loss of the crop of nuts often occurs yearly. Two very excellent varieties, Georgia and Delmas, at one time generally propagated and planted in the southeastern United States, have been top-worked to more resistant sorts. The discarding of these two varieties was wholly on account of their extreme susceptibility to scab. The Schley, which is the most excellent of all the varieties of pecans, is now on trial by growers; and some orchardists having a large Schley acreage or having this variety scattered throughout their orchards seem to be in favor of cutting it back and top-working it to varieties requiring no spraying for the control of scab.

In addition to the direct loss due to the destruction of the crop by the scab fungus, pecan growers have incurred a heavy expense in the past in the process of changing the varieties in the orchard as a means of eradicating the disease. Much time is also lost in the three to five years required for a new top to form on a large tree.

#### RELATIVE SUSCEPTIBILITY OF COMMERCIAL VARIETIES OF THE PECAN

Of the more popular varieties growing within the region of the most frequent summer rains, that is, a narrow belt along the Gulf coast about 50 miles wide extending from Baton Rouge, La., to Tallahassee, Fla., more than half can be classed as very susceptible. The following two groups of pecan varieties will give readers a fairly accurate conception of the relative susceptibility of those most generally grown in the South. The names in each group are arranged in the order of their degree of susceptibility or resistance.

*Susceptible varieties.*—San Saba, Delmas, Georgia, Alley, Schley, Pabst, Van Deman, Mobile.

*Resistant varieties.*—Moneymaker, Stuart, Teche, Curtis, Frotscher, Success, Moore.

North of the Gulf coast area a lesser number of varieties are at present attacked. In the latitude of Albany, Ga., the susceptible varieties are limited to Delmas, Georgia, Alley, and Schley; in the vicinities of Macon, Ga., Montgomery, Ala., and Meridian, Miss., only the Delmas and Georgia, as a rule, are attacked. The percentages of humidity and frequency of rains are apparently not the only factors that influence the severity of the attack. Other factors, such as the preponderance of certain varieties in a locality and the age of the trees, play minor parts in aiding the disease to become epiphytotic. As evidenced by what is going on in the coastal region, the fungus seems so to adapt itself to the more resistant varieties that it can finally injure them severely.

#### EXPERIMENTS ON CONTROL

The pioneer work on pecan-scab control was conducted at Orangeburg, S. C., in 1909, and at Baconton, Ga., in 1911 by M. B. Waite, in charge of the Office of Fruit-Disease Investigations. The varieties used in these experiments were San Saba, Kincaid, and Georgia Giant. The spray outfits available for use at that time equipped with disk nozzles and ordinary extension rods were inadequate to spray the larger trees.<sup>2</sup> Nevertheless, on small trees these early experiments clearly demonstrated that pecan scab could be successfully controlled.

The recent experimental work of the writers has demonstrated that pecan scab can be controlled much more easily than the results of their earlier experiments indicated. Their first attempts to control the disease were made on two of the most susceptible varieties, Delmas and Georgia. Moreover, at that time, the importance of

<sup>2</sup> For a discussion of spray outfits constructed to spray large pecan trees, the reader is referred to pages 3-5 of Farmers' Bulletin No. 1129, Diseases of Southern Pecans, by S. M. McMurrin and J. B. Demaree.

practicing sanitary methods in the pecan orchard had not yet become apparent. Consequently, the results of their earlier attempts were not encouraging. Rather than to engage in an uncertain fight against the scab on the varieties Delmas and Georgia, the growers preferred to cut back many thousand trees of these two varieties and bud them over to such varieties as Stuart, Moneymaker, and Moore. Of the better cultivated varieties, Delmas and Georgia prior to 1917 were the only ones seriously affected with scab. Some years ago the growers believed that the disease could be practically eradicated by the elimination of those two varieties. Coincident with the process of the elimination of the Delmas and Georgia, the fungus was gradually adapting itself to other varieties of high quality and establishing itself on them. Fortunately, the disease is more easily controlled on varieties which have recently become susceptible. At present the scab fungus is rapidly adapting itself to the Schley, Pabst, and Alley varieties. This increasing spread of the disease is especially noticeable in the southern portions of Georgia, Alabama, and Mississippi.

Extensive spraying experiments for scab control have been made yearly by the senior writer since 1918. The first experiments were only partially successful. The early failures were due mainly to a lack of knowledge concerning the habits and nature of the fungus causing the disease and to a disregard of the sources of infection. A wide range of spray materials has been used. In 1922 extensive tests were made with Bordeaux mixture, sulphur compounds, and certain dusts. Bordeaux mixture has proved to be the most effective spray so far tried and has been generally adopted as the standard fungicide, disregarding the fact that under certain unfavorable weather conditions serious foliage injury may result. Lime-sulphur solution has given fairly good results in moderately infected orchards and will undoubtedly be used more generally in the future as a midsummer spray for the purpose of eliminating the danger of foliage injury in late summer.

The number of applications of spray necessary to effect commercial control varies according to the variety, weather conditions, and the distribution of the disease inoculum in the orchard. In 1922 five to six applications of Bordeaux mixture were required in a Delmas orchard at Dewitt, Ga. This orchard had received no previous treatment, and there was an abundance of the inoculum. Four applications of spray, the first two being Bordeaux mixture and the last two lime-sulphur, gave excellent control in a near-by orchard the same season. The latter orchard had been sprayed the previous season and therefore was relatively free from sources of infection. Six applications of Bordeaux mixture failed to control the disease satisfactorily in 1923 on the Delmas variety at Dewitt, Ga., and also on the Schley variety at Quincy, Fla. Rains were unusually frequent during that season and were undoubtedly the principal cause of the poor control.

A second factor influencing the control on the less susceptible variety, Schley, at Quincy, Fla., was the insanitary condition of the orchard. The ground was not plowed and was covered with the previous year's pecan leayes, leaf stems, and nut shucks. This re-

sulted in a heavy leaf infection on the lower limbs during early spring, and the disease gradually spread throughout the entire tree regardless of six applications of spray. The same year results were reversed at Thomasville, Ga., with one-half the number of treatments in an orchard where sanitary measures were observed. Frequent rains also occurred at Thomasville. The results obtained in these two orchards indicate in a striking manner the beneficial effects derived from disposing of the sources of infection by plowing under the old leaves and shucks.

Very satisfactory control resulted from four applications of Bordeaux mixture in a Schley orchard at Monticello, Fla., in 1924. In 1925 three applications of the same spray gave perfect commercial results in the same orchard. This orchard was sprayed during the two seasons previous to 1924, the first year of the experimental spraying. Special attention was given to sanitary measures during both seasons the experiments were run. By 1925 there was ample evidence to show that the pecan-scab fungus had been almost eradicated from the experimental block of trees, as there was an almost entire absence of early leaf infections. The disease had become established in this orchard in 1921.

Another very striking example of the cumulative effect of spraying was demonstrated in a Schley orchard at Thomasville, Ga. This orchard was well cared for. The trees were 18 years old and averaged about 50 feet in height and 45 feet in spread of limbs. The scab disease had completely destroyed the crop of nuts for several years prior to the beginning of the experiment in 1924. During the spring of that year many of the terminal twigs, especially the highest ones, were peppered with hold-over stromata from the previous year's infections. Although the sources of infection on the orchard floor were plowed under, the great abundance of spores developing from the twig stromata resulted in a heavy early spring leaf infection. Five applications of spray were necessary to effect a commercial control of the disease. Because the spray applied during 1924 had almost completely prevented twig infection in the orchard, in 1925 only two applications, coupled with orchard sanitary measures, were needed to give excellent control.

Foliage injury caused by spray materials is a factor that has been given careful consideration in all experimental work done by the writers. While Bordeaux mixture is the most effective spray yet used for pecan-scab control, unfortunately in some seasons it causes serious foliage injury. Weather conditions, a deficiency of soil moisture during the latter half of the growing season, or any factor which lowers the vigor of the trees appears to predispose them to spray injury. The spraying of pecan trees with Bordeaux mixture at the time of a drought during July, August, or September usually causes partial or complete defoliation and the consequent loss of the crop of the current year. Trees prematurely defoliated fail to set a crop the year following, so that severe foliage injury means the loss of two crops of nuts.

Two or three applications of Bordeaux mixture during the months of May and June have never been known to result in any evident foliage injury. On the contrary, the writers have observed very

striking beneficial effects to the foliage as a result of one or two applications of Bordeaux mixture made prior to June 15. In orchards comparatively free of the scab inoculum two or three applications should not only control the disease but also protect the leaves from infection by other fungi and enable the trees to retain their leaves several weeks longer than unsprayed ones. The same beneficial effect has also been noted in orchards when spray was applied not only in May and June, but also in July and August. In such cases the trees were unusually vigorous or they had received an adequate supply of soil moisture.

Lime-sulphur solution also causes some injury to individual leaflets, but the injury can not be considered serious and never causes defoliation even during a late-season drought.

#### RECOMMENDATIONS FOR THE CONTROL OF PECAN SCAB

By properly applying both sanitary and prophylactic measures the scab disease is relatively easy to control. The writers have observed that the scab fungus becomes established in an orchard rather slowly. The spores apparently are not carried from orchard to orchard in any great numbers by such agencies as wind, birds, and insects; but the great number of sources of infection resulting in a well-established epiphytotic is undoubtedly developed slowly from a few scattered original infections in each tree.

In southern Georgia pecan leaves begin to unfold during the last week of March and, as the new terminals elongate, continue to unfold over a period of about three weeks. The pistillate blossoms become exposed to view during the last few days of April. Spray applied to the very young leaves may cause serious foliage injury. It is not considered good practice to spray while the pistillate blossoms are exposed prior to pollination. Therefore, there is a period of four to five weeks during which time it is not considered safe to spray even though the leaves are extremely susceptible to infection. The importance of preventing the leaves from becoming infected can not be overemphasized. Each infection produces hundreds of spores capable of infecting the young nuts.

#### SANITARY METHODS

The object of the orchard sanitary methods is to dispose as far as possible of all hold-over sources of infection as a precaution against early leaf infection. The fungus lives through the winter on infected twigs, shucks, and leaf stems. Frequently the infected shucks of the previous year will cling to the twigs all winter and become important sources of the early spring leaf infections. All such shucks should be removed from the trees prior to the opening of the spring buds. Infected leaf stems, shucks, and possibly the leaves are potential sources of infection. The most practical method of disposing of these is to plow them under with a turnplow. Disappointment usually results from attempting to turn under the débris with a disk harrow. The turnplow places the infected parts so deeply beneath the surface that they are not dragged out by the usual summer cultivating methods. There is no known method that will effectively destroy the sources of infection on the twigs. Summer spraying,

however, will largely prevent twig infection. The twigs should therefore be relatively free from scab lesions after the first season of spraying.

#### PROPHYLACTIC METHODS

The prophylactic methods consist in applying fungicides during the summer months. In the light of our present knowledge, it seems best to apply a 3-3-50 strength of Bordeaux mixture immediately after the tips of the pistillate blossoms have turned brown, indicating that pollination has taken place. The object of the first application should be to protect the leaves from becoming infected. The leaves are susceptible to infection only while they are young. After they have taken on the dark-green color of maturity they are practically immune. Since primary infection of leaves takes place on the under surface, the first application, if made in time, should be applied to the under surface as well as the upper. Should the first application be unavoidably delayed until the latter part of May or the first of June in southern Georgia little or nothing will be gained by applying the fungicide to the under surface of the leaves.

Normally, rains occur infrequently during May throughout the southern pecan belt. As a rule, therefore, the second application need not be made until the summer rains have commenced. Weather conditions and the degree of control already obtained should determine the approximate date of the third application. If Bordeaux mixture is used for the third application, it seems best on account of probable foliage injury to apply it not much later than July 1. Unless the first two applications have failed to keep the disease in check, lime-sulphur solution (1 gallon to 50 gallons of water) is safer to use for subsequent applications if the number necessary to bring the desired results exceeds three.

The grower, when spraying for pecan scab, should appreciate the fact that perfect control is not necessary. (Table 1.) A few late infections on the shucks will not depreciate the value of the nuts. It is far better to lose a few nuts than to overspray and cause serious foliage injury, resulting in the loss of the entire crop. In an orchard composed of such varieties as Schley, Alley, or Pabst, sprayed the previous year so that no twig stromata are present, two or three applications of Bordeaux mixture at intervals of three to four weeks, and possibly one additional application of lime-sulphur solution, if properly applied, should give commercial control during seasons of normal rainfall, provided the recommended sanitary measures have been followed.

TABLE 1.—*Tentative spray schedule for the control of pecan scab*

Applica- tion	Date	Materials	Purpose
First....	Immediately after pollination has taken place (from May 1 to 15 in southern Georgia).	3-3-50 Bordeaux mixture.....	To protect leaves.
Second....	3 to 4 weeks later.	.....do.....	To protect young nuts.
Third....	2 to 3 weeks after second application.	3-3-50 Bordeaux mixture or lime-sulphur solution, 1 gallon in 50 gallons of water.	Do.
Fourth....	3 to 4 weeks after third application.	Lime-sulphur solution, 1 gallon in 50 gallons of water.	To protect nuts. Not always necessary.

**PREPARATION OF BORDEAUX MIXTURE**

A 3-3-50 Bordeaux mixture for use in a 200-gallon power outfit may be prepared in the following manner:

1. Prepare a stock solution of bluestone by suspending 50 pounds in a sack at the top of a 50-gallon barrel of water.
2. Slake 50 pounds of quicklime to a thick paste and add water to make 50 gallons.
3. After stirring the stock bluestone solution (1), pour 12 gallons (carrying 12 pounds of bluestone) into the spray tank, which should be about three-fourths full of water.
4. After thoroughly stirring the stock milk of lime (2), measure out 12 gallons (carrying 12 pounds of lime) and pour through a strainer into the spray tank while the agitator is running.
5. Complete filling the tank with water and the spray is ready to apply.

If hydrated lime is used as a substitute for the quicklime, 16 gallons should be used in step 4.

**SUMMARY**

Pecan scab is a disease of considerable economic importance and wide distribution throughout the Southeastern States.

The disease is caused by a parasitic fungus which attacks nuts, growing twigs, and leaves of susceptible varieties. Some injury is done to all parts attacked, but the greatest damage is to the nuts.

Of the more popular varieties growing within the region of the most frequent summer rains, a narrow belt along the Gulf coast about 50 miles wide extending from Baton Rouge, La., to Tallahassee, Fla., more than half can be classed as very susceptible.

Extensive experiments on the control of the disease have been carried on for a number of years. The recent experimental work of the writers has demonstrated that pecan scab can be controlled much more easily than the results of their earlier experiments indicated.

The control measures recommended consist of spraying at suitable times with Bordeaux mixture or lime-sulphur solution. As a supplementary measure, orchard sanitation is recommended.

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